AsiaIntervention 2022;8:123-131

Percutaneous coronary intervention in patients aged 80 years old and above: a systematic review and meta-analysis

Norman H. Lin[1], MBBS; Jamie S-Y. Ho[2], MBBChir; Andie Hartanto Djohan[1], MBBS, MRCP; Vanda Wen-Teng Ho[3], MBBChir, MRCP; Yao Neng Teo[4]; Yao Hao Teo[4], MBBS; Nicholas L. Syn[4], MBBS; Yin Nwe Aye[1], MBBS, MRCP; Rodney Y.H. Soh[1], MBBS, MRCP; Tiong-Cheng Yeo[1,4], MBBS, FAMS, FACC, MRCP; Hui-Wen Sim[1], MBBS, MRCP; Huay-Cheem Tan[1,4], MBBS, FAsFC, FAMS, FSCAI, FRCP, FACC, FAPSIC; Mark Y. Chan[1,4], MBBS, PhD, MRCP, MHS, MMed; Ching-Hui Sia[1,4]*, MBBS, FAMS, MRCP, MMed, EMBA, MCI

1. Department of Cardiology, National University Heart Centre, Singapore; 2. Academic Foundation Programme, Royal Free London NHS Foundation Trust, London, United Kingdom; 3. Division of Geriatric Medicine, University Medicine Cluster, National University Health System, Singapore; 4. Department of Medicine, Yong Loo Lin School of Medicine, National University of Singapore, Singapore

N. H. Lin and J. S-Y. Ho contributed equally as first authors

This paper also includes supplementary data published online at: https://eurointervention.pcronline.com/doi/10.4244/AIJ-D-21-00040

KEYWORDS

- ACS/NSTE-ACS
- NSTEMI
- STEMI

Abstract

Background: Ischaemic heart disease remains the main cause of death in the world. With increasing age, frailty and comorbidities, senior patients aged 80 years old and above who undergo percutaneous coronary intervention (PCI) are at higher risk of mortality and other complications.

Aims: We aimed to examine the overall outcomes for this group of patients.

Methods: Four databases (PUBMED, EMBASE, SCOPUS and CENTRAL) were searched. Studies with patients aged 80 years old and above who underwent PCI for all indications were included. Pooled outcomes of all-cause death, cardiac death, in-hospital death, subsequent stroke/transient ischaemic attack (TIA), subsequent myocardial infarction (MI), subsequent congestive cardiac failure (CCF), and overall major adverse cardiac events (MACE) were obtained for meta-analysis.

Results: From 2,566,004 patients, the pooled cumulative incidence of death was 19.22%, cardiac death was 7.78%, in-hospital death was 7.16%, subsequent stroke/TIA was 1.54%, subsequent MI was 3.58%, subsequent CCF was 4.74%, and MACE was 17.51%. The mortality rate of all patients was high when followed up for 3 years (33.27%). ST-elevation myocardial infarction patients had more outcomes of in-hospital death (14.24% vs 4.89%), stroke/TIA (1.93% vs 0.12%), MI (3.68 vs 1.55%) and 1-year mortality (26.16% vs 13.62%), when compared to non-ST-elevation myocardial infarction patients.

Conclusions: There was a high mortality rate at 1 year and 3 years post-PCI in the overall population of senior patients aged 80 years old and above, regardless of indication. This necessitates further studies to explore the implications of these observations.

**Corresponding author: Department of Cardiology, National University Heart Centre Singapore, 1E Kent Ridge Road, NUHS Tower Block Level 9, Singapore 119228. E-mail: ching_hui_sia@nuhs.edu.sg*

SUBMITTED ON 04/11/2021 - REVISION RECEIVED ON 1st 20/02/2022 / 2nd 02/05/2022 - ACCEPTED ON 01/06/2022

DOI: 10.4244/AIJ-D-21-00040

Abbreviations

ACS	acute coronary syndrome
CABG	coronary artery bypass grafting
CCF	congestive cardiac failure
MACE	major adverse cardiac events
MI	myocardial infarction
NSTEMI	non-ST-elevation myocardial infarction
PCI	percutaneous coronary intervention
STEMI	ST-elevation myocardial infarction
TIA	transient ischaemic attack

Introduction

There is an increasing burden of coronary artery disease around the world[1]. Ischaemic heart disease remains the main cause of death globally[2]. With increasing age, frailty and comorbidities, senior patients aged 80 years old and above who develop ischaemic heart disease are at higher risk of mortality and other complications. Most guidelines from major cardiac societies have advocated for invasive treatment for patients who develop ischaemic heart disease, acute coronary syndromes (ACS; which include ST-elevation myocardial infarction [STEMI], non-ST-elevation myocardial infarction [NSTEMI], and unstable angina [UA])[3-6]. However, most of these guidelines were derived from evidence that studied younger patients, as senior patients aged 80 years old and above were often underrepresented[7] and, hence, less invasively managed[1,8]. The paucity of data on senior patients aged 80 years old and above has also led to major cardiac societies to call for more studies in this age group[8,9].

To the best of our knowledge, there has been no systematic review or meta-analysis thus far that examines the overall outcomes of senior patients aged 80 years old and above undergoing percutaneous coronary intervention (PCI). Recent studies have demonstrated the benefits of an invasive approach in senior patients aged 80 years old and above. This entailed selecting them for invasive coronary angiogram, and subsequently proceeding with the appropriate management plan which included coronary artery bypass grafting (CABG), PCI, or optimal medical therapy (OMT)[10]. However, there are minimal studies describing the outcomes of performing PCI itself in this age group. Contemporary evidence has thus far proven survival benefits of an invasive approach in senior patients aged 80 years old and above with ACS and, to a lesser extent, morbidity benefits (in relieving anginal symptoms) in patients with stable heart disease[11].

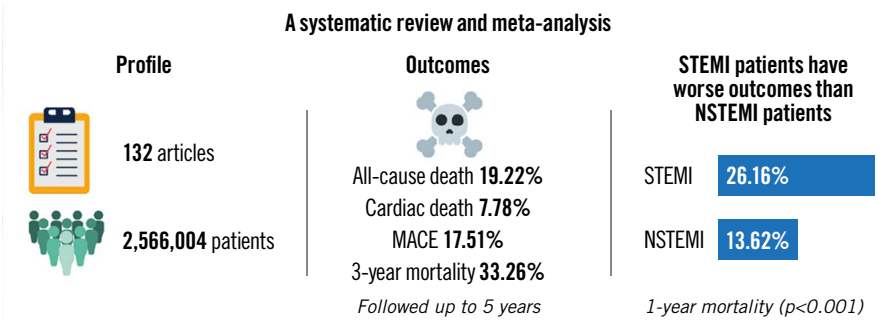
There is increased interest in the "oldest-old", which is defined as people aged 80 years old and above, and the concept of successful ageing in this age group[12-15]. People in this age group are frailer, experience greater health decline, and have higher rates of hospitalisation, comorbidities and mortality. Even though they may reap the benefits of PCI in the context of ischaemic heart disease and myocardial infarction (MI), this needs to be balanced with the relative higher risk of harm from invasive interventions. Frailty not only contributes to the risk of mortality from the disease process itself but also from the intervention[16,17]. To allow clinicians and interventionists to better manage patients in this age group, this systematic review and meta-analysis aimed to study the outcomes of PCI in senior patients aged 80 years old and above, regardless of their underlying indications **(Central illustration)**.

Methods

Ethics approval and consent to participate was not required for this study as this study used publicly available data. We searched 4 databases (PUBMED, EMBASE, SCOPUS and CENTRAL) in February 2021, with the following search terms: "percutaneous coronary intervention" OR "PCI" OR "myocardial revasculari*"

AsiaIntervention

CENTRAL ILLUSTRATION PCI outcomes in seniors aged 80 years old and above.



Mortality rate of senior patients aged 80 years old and above, regardless of indications, was high. The 1-year and 3-year outcomes post-PCI of this population group were poor.

MACE: major adverse cardiac events; NSTEMI: non-ST-elevation myocardial infarction; PCI: percutaneous coronary intervention; STEMI: ST-elevation myocardial infarction

OR "coronary angioplasty" OR "percutaneous coronary revascularisation*" OR "primary PCI" OR "PPCI" OR "coronary stent" OR "balloon angioplasty" OR "coronary atherectomy" AND "elderly" OR "old age" OR "octogenarian" OR "older adult" OR "older age". We identified studies that included PCI in patients who were 80 years old and above. Studies that only included coronary angiography without the use of PCI and studies that did not include the subgroup data of PCI were excluded. We included studies with all indications for PCI, including stable coronary artery disease and ACS. Only studies published in English were included. To keep the dataset contemporary, studies with data prior to the year 2000 were excluded, as drug-eluting stents (DES) were introduced in the early 2000s. Full papers were obtained either via retrieval from the databases or by contacting the relevant authors if the papers could not be obtained from the databases. Abstracts were included if they included the relevant parameters. We included all studies, according to the population, intervention, comparison, outcome, and study design inclusion and exclusion criteria **(Table 1)**.

Table 1. PICOS, inclusion and exclusion criteria.

PICOS	Inclusion criteria	Exclusion criteria
Population	Patients 80 years old and above	Patients below 80 years old
Intervention	Underwent PCI, regardless of indications	Did not undergo PCI Only had coronary angiography without PCI No specific subgroup analysis for PCI patients (for those who underwent coronary angiography)
Comparison	Nil	
Outcomes	All-cause death, cardiac death, in-hospital death, subsequent stroke/TIA, subsequent MI, subsequent CCF, and overall MACE	
Study design	Full articles available in English Study type: Abstracts, posters, randomised controlled trials, cohort studies Databases: PUBMED, EMBASE, SCOPUS and CENTRAL	Meta-analysis, systemic reviews, case reports Studies in foreign language Dataset prior to year 2000

CCF: congestive cardiac failure; MACE: major adverse cardiac events; MI: myocardial infarction; PCI: percutaneous coronary intervention; TIA: transient ischaemic attack

Baseline characteristics included mean age, smoking history, history of hypertension, diabetes, hyperlipidaemia, stroke, atrial fibrillation, congestive cardiac failure, peripheral vascular disease, chronic kidney disease and history of PCI or CABG. We then obtained the outcomes of all-cause death, cardiac death, in-hospital death, subsequent stroke/transient ischaemic attack (TIA), subsequent MI, subsequent congestive cardiac failure (CCF) which developed as a complication of MI, and overall major adverse cardiovascular events (MACE). MACE was defined as a composite of death, stroke/TIA, MI, CCF, or revascularisation with either PCI or CABG. Data, which were reported in percentages, were converted to absolute numbers by calculation and rounded to the nearest whole number.

STATISTICAL ANALYSIS

Extracted data were used to analyse the pooled cumulative incidence with 95% confidence intervals (CI) for outcomes of PCI. We calculated cumulative incidences utilising the 1-step generalised linear mixed-effects model (GLMM) method employing the metaprop_one routine in Stata (version 16.0; StataCorp). Compared to traditional 2-stage methods, this method is proven to produce smaller errors, less biased estimates, and greater coverage probabilities[18,19]. When the 1-stage model failed to converge, a random-effects inverse variance-weighted meta-analysis using the Freeman-Tukey transformation was utilised to pool proportions. The random-effects model was adopted in all analyses to account for anticipated heterogeneity in the observational estimates[20]. Between-study heterogeneity was assessed using the I^2 statistic[21]. An I^2 value of <30% indicates low heterogeneity between studies, an I^2 of 30-60% indicates moderate heterogeneity, and an I^2 of >60% indicates substantial heterogeneity. A 2-sided p-value of <0.05 was considered as statistically significant. The meta-analysis was reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines **(Supplementary Table 1)**[22]. The various studies were appraised via the Newcastle-Ottawa scale[23] **(Supplementary Table 2, Supplementary Table 3)**.

Results

The PRISMA flow chart is presented in **Figure 1**. A literature search of the 4 databases yielded a total of 4,358 results. Three researchers were involved in the screening process (N.H. Lin, J.S-Y. Ho and C-H. Sia). A total of 4,226 articles were excluded, according to the criteria described in the flow chart, and 94 full papers and 38 abstracts were ultimately included for the analysis and discussion in this paper. The pooled data from these articles were dated from 2000 to 2018. Thirty regions **(Supplementary Table 4)** were represented, and common sources of studies included the USA, Japan, the UK and Italy. Sixty-two out of 132 papers reported an ACS rate of more than 50%. A summary of the baseline characteristics is described in **Supplementary Table 5**.

POOLED OUTCOMES IN ALL PATIENTS 80 YEARS OLD AND ABOVE

In total, we pooled 132 articles to form an overall cohort of 2,566,004 patients aged 80 years old and above in our meta-analysis, including all indications for PCI. The outcomes **(Table 2)** were as follows: the cumulative incidence of all-cause death **(Figure 2)** was 19.22% (95% CI: 16.83-21.72), cardiac death was 7.78% (95% CI: 5.53-10.85), in-hospital death was 7.16% (95% CI: 6.39-7.97), subsequent stroke/TIA was 1.54% (95% CI: 0.84-2.40), subsequent MI was 3.58% (95% CI: 2.53-4.79), subsequent CCF was

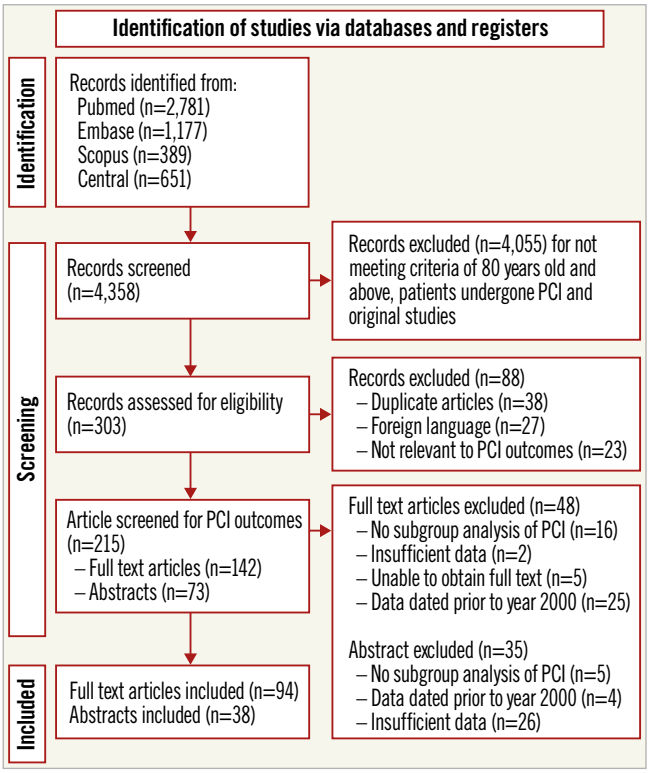


Figure 1. *PRISMA flowchart. PCI: percutaneous coronary intervention*

4.74% (95% CI: 2.12-10.28), and MACE was 17.51% (95% CI: 14.20-21.08). The overall follow-up period extended up to 5 years.

One-year overall outcomes based on a pooled cohort of 36,919 patients from 52 articles and 3-year outcomes based on a pooled cohort of 6,169 patients from 9 articles demonstrated increasing rates of all-cause death (14.73% vs 33.27%), cardiac death (5.95% vs 22.81%) and subsequent CCF (4.74% vs 17.45%) over time.

Table 2. Pooled outcomes in all patients 80 years old and above.

Outcomes	All outcomes % (95% CI)	1 year	3 years
Death	19.22 (16.83-21.72)	14.73 (12.08-17.84)	33.27 (27.16-39.68)
Cardiac death	7.78 (5.53–10.85)	5.95 (4.04-8.69)	22.81 (16.02-31.39)
In-hospital death	7.16 (6.39-7.97)		
Stroke/TIA	1.54 (0.84-2.40)	1.34 (0.83-2.16)	3.54 (0.91-12.84)
MI	3.58 (2.53-4.79)	2.10 (1.36-3.21)	5.79 (2.96-11.03)
CCF	4.74 (2.12-10.28)	1.14 (0.05-22.04)	17.45 (12.16-24.40)
MACE	17.51 (14.20-21.08)	15.23 (12.44-18.51)	14.93 (12.95-17.15)

CCF: congestive cardiac failure; CI: confidence interval; MACE: major adverse cardiac events; MI: myocardial infarction; TIA: transient ischaemic attack

SUBGROUP ANALYSES

We were also able to perform a subgroup analysis of the clinical outcomes in STEMI and NSTEMI patients.

POOLED OUTCOMES IN STEMI PATIENTS

We pooled 27 articles to create a cohort of 106,343 patients who had ST-elevation myocardial infarction. In this cohort, the previous history of MI, PCI, and CABG in general (if reported) was less than 20%. The outcomes were as follows: the cumulative incidence of all-cause death was 23.08% (95% CI: 17.43-29.89), cardiac death was 9.42% (95% CI: 2.67-28.26), in-hospital death was 14.24% (95% CI: 12.09-16.53), subsequent stroke/TIA was 1.93% (95% CI: 12.09-16.53), subsequent MI was 3.68% (95% CI: 2.21-6.06), subsequent CCF was 13.08% (95% CI: 9.19-18.30), and MACE was 12.19% (95% CI: 5.11-26.35). The follow-up period extended up to 2 years, with most studies following patients up to 1 year.

POOLED OUTCOMES IN NSTEMI PATIENTS

We combined 7 articles to create a pooled cohort of 12,211 patients who had non-ST-elevation myocardial infarction. The previous history of MI was 20-40%, PCI 10%-20% and CABG 6-7% (if reported). The outcomes were as follows: the cumulative incidence of all-cause death was 14.74% (95% CI: 7.40-27.21), in-hospital death was 4.44% (95% CI: 2.65-7.36), subsequent stroke/TIA was 0.19% (0.07-0.50), subsequent MI was 1.55% (0.92-2.58), and MACE was 10.93% (95% CI: 9.79-12.18). The follow-up period extended up to 2 years, with most studies following patients up to 1 year.

STEMI PATIENTS HAD MORE OUTCOMES THAN NSTEMI PATIENTS

Overall, patients with STEMI had poorer outcomes as compared to NSTEMI patients **(Table 3)** in the outcomes of in-hospital death (STEMI 14.24%, NSTEMI 4.89%; p-value <0.001), subsequent stroke/TIA (STEMI 1.93%, NSTEMI 0.12%; p-value <0.001), and subsequent MI (STEMI 3.68%, NSTEMI 1.55%; p-value=0.039). There were no significant differences in all-cause death (STEMI 23.08%, NSTEMI 14.74%; p-value=0.156) and MACE (STEMI

Table 3. STEMI versus NSTEMI patients.

Outcomes	STEMI % (95% CI)	NSTEMI % (95% CI)	*p*-value
Death	23.08 (17.43-29.89)	14.74 (7.40-27.21)	0.156
In-hospital death	14.24 (12.09-16.53)	4.89 (2.38-7.71)	<0.001
Stroke/TIA	1.93 (1.12-2.90)	0.12 (0.00-0.36)	<0.001
MI	3.68 (2.21-6.06)	1.55 (0.92-2.58)	0.039
MACE	12.19 (5.11-26.35)	10.93 (9.79-12.18)	0.809

CI: confidence interval; MACE: major cardiac adverse events; MI: myocardial infarction; NSTEMI: non-ST-elevation myocardial infarction; STEMI: ST-elevation myocardial infarction; TIA: transient ischaemic attack

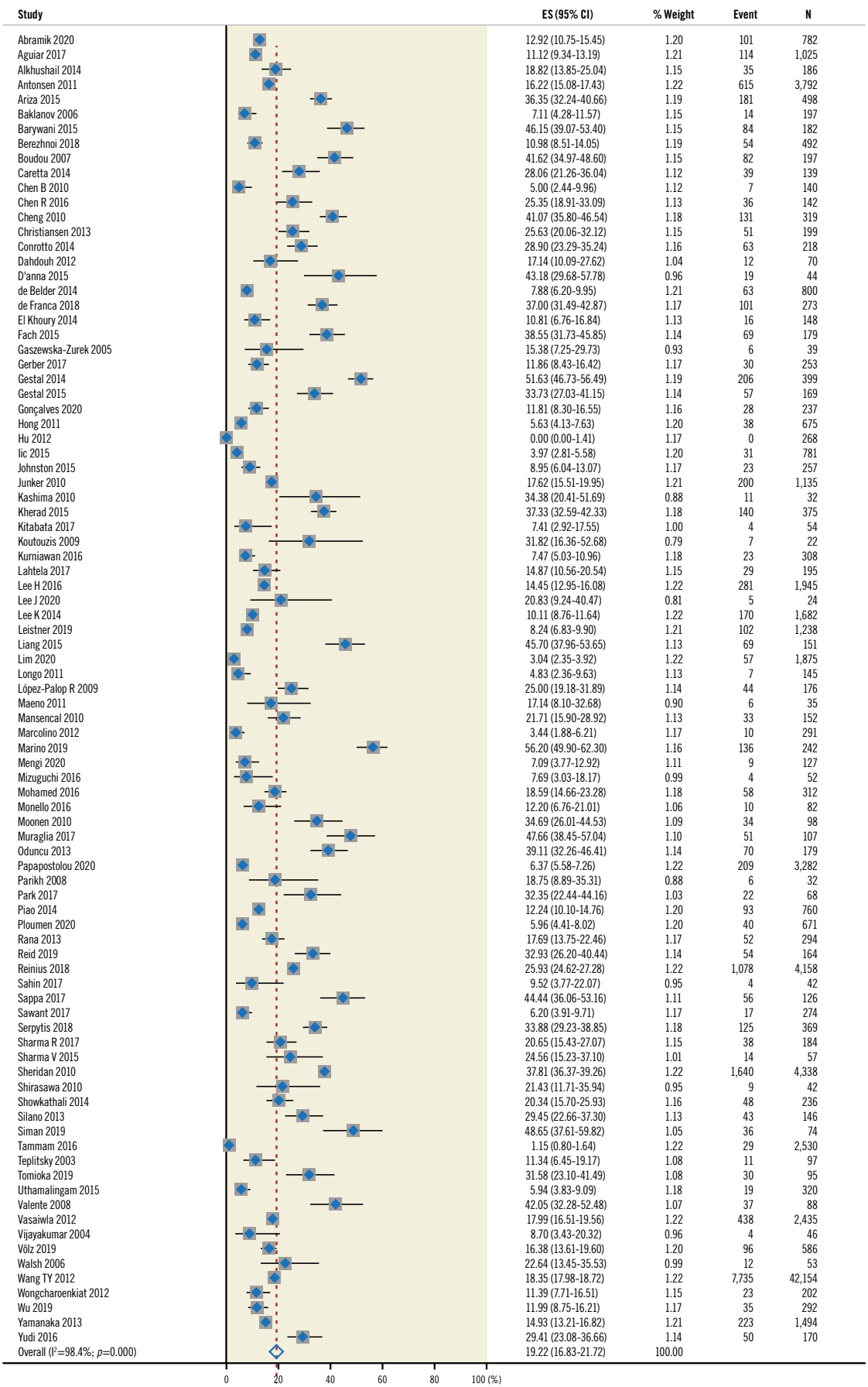


Figure 2. *All-cause death in the overall population. CI: confidence interval; ES: effect size*

12.19%, NSTEMI 10.39%; p-value=0.809). However, 1-year outcomes showed significant differences in all-cause death between STEMI and NSTEMI patients (STEMI 26.16%, NSTEMI 13.62%; p-value <0.001) **(Figure 3)**.

ISCHAEMIC TIME

In studies that reported ischaemic time, senior patients often had longer ischaemic times than the younger population. For example, Helft et al[24] reported a median time from onset of symptoms to intervention of 251 min (versus 195 min in a younger group with a mean age of 61 years). Fach et al[25] and Papapostolou et al[26] reported a door-to-balloon time of 58 min (versus 43 mins in patients younger than 75 years old) and 87 min (versus 77 min in patients younger than 80 years old), respectively.

Discussion

Based on our meta-analysis, in senior patients aged 80 years old and above who underwent PCI, there was a pooled cumulative incidence of all-cause death of 18.55%, in-hospital death was at 6.7% and cardiac death was at 7.6%. There was also a 17.89% prevalence of MACE. Moreover, STEMI patients experienced a higher rate of in-hospital death, subsequent stroke/TIA and subsequent MI. The death rate was higher than that of a younger population (6.5%, mean age 59 to 65) as described in another meta-analysis of 5 studies by Stergiopoulos et al[27], and similar to those previously reported by Avezum et al in the more senior age groups (18.4%, mean age 87.8)[28]. However, this is not unexpected as senior patients often have more comorbidities and poorer prognostic factors[28,29].

This high mortality rate was likely contributed to by the prevalence of underlying cardiovascular disease since most studies reported at least a 50% incidence of ACS. Other factors that have been previously quoted in other studies as contributing to the outcomes include fear of discovery of serious illnesses, atypical symptoms that mask the diagnosis of ACS (silent MI), reduced mobility that impedes access to healthcare, and economic concerns with regard to affordability of care or the lack of a dedicated caregiver[30-33], all of which contribute to delayed presentations. Cognitive impairment may also mask symptom presentation[34].

Although the rate of all-cause death was 18.55%, cardiac death constituted only 7.6%, which highlights that non-cardiac causes were major contributors of death. Besides ischaemic heart disease, the next most common causes of death globally include stroke, chronic obstructive pulmonary disease and lower respiratory infections (such as pneumonia)[2]. In this ageing population, senior patients have more chronic diseases than younger patients, which predispose them to increased rates of mortality. Senior patients often have other concomitant illnesses such as cancer, stroke, pneumonia, as well as urinary tract infection[35]. These patients are frailer, have poorer myocardial reserves and, therefore, are more vulnerable to stressors and clinical insults from illnesses such as myocardial infarction[36]. This competing risk of death, of which frailty is a proven indicator of mortality after PCI[37], may explain the relative higher proportion of death being non-cardiac in nature.

Our analysis also demonstrated that STEMI patients had poorer outcomes as compared to NSTEMI patients. Notably, they had a higher cumulative incidence of in-hospital death (STEMI 14.24% vs NSTEMI 4.89%), stroke/TIA (STEMI 1.93% vs NSTEMI 0.12%) and MI (STEMI 3.68% vs NSTEMI 1.55%). When followed up for 1 year, they had a significantly higher rate of all-cause death (STEMI 26.16% vs NSTEMI 13.62%; p<0.001), and in-hospital death (STEMI 14.53% vs NSTEMI 7.02%). Due to the underlying pathophysiology of transmural infarct in STEMI, the effect of myocardial necrosis is more pronounced in the older age group. Senior patients with STEMI often have higher rates of

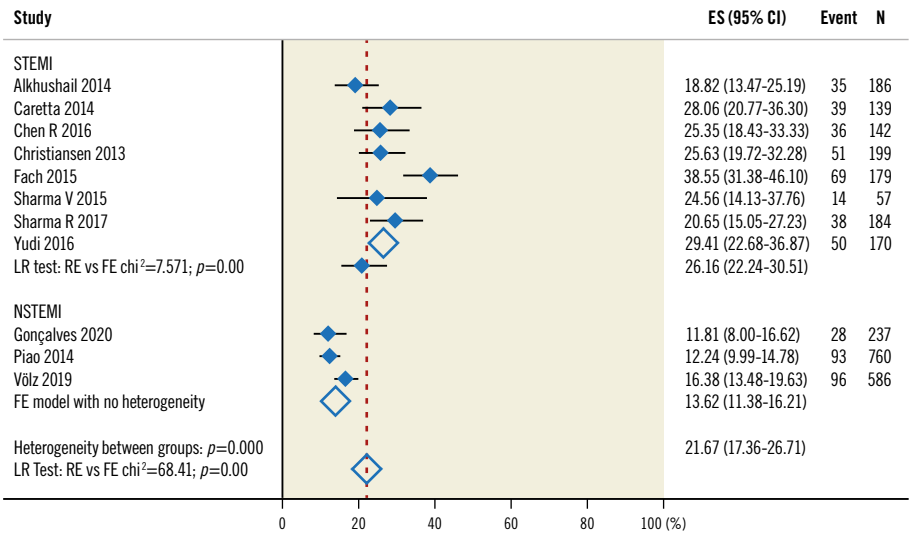


Figure 3. *Three-year all-cause death in NSTEMI and STEMI populations.. CI: confidence interval; ES: effect size; FE: fixed effects; LR: likelihood ratio; NSTEMI: non-ST-elevation myocardial infarction; RE: random effects; STEMI: ST-elevation myocardial infarction*

post-MI complications, including various mechanical and electrical complications, leading to higher mortality rates[38,39]. To determine the significance of the poorer 1-year adverse outcomes in STEMI patients as compared to NSTEMI patients necessitates closer follow-up in this subgroup of patients.

Longer-term 1-year and 3-year outcomes showed increasing cumulative incidences. For example, the mortality rate at 1 year was at 14.61% and 33.27% at 3 years. The 3-year outcomes were also particularly high, with a cumulative incidence of 22.81% for cardiac death, 3.54% for stroke/TIA, 5.79% for MI, 17.45% for CCF, and 14.93% for MACE. Clinicians may need to consider closer follow-up in the longer term. However, it is also important to note that the studies pooled for the 3-year outcomes included papers that compared CABG vs PCI outcomes[40,41], of which one study had patients with multivessel disease[41], and one study had patients with left main disease[42]; hence, the data might have been confounded by the severe underlying disease. However, more studies are required to further explore the implications of these observations and to determine if current clinical practice is sufficient to manage the long-term outcomes of senior patients with ACS undergoing PCI.

Although the risks of PCI in patients aged 80 years old and above were higher than in the younger population, current evidence still points towards the benefits of PCI in reducing death, cardiac death, and MI in patients with unstable coronary artery disease in the general population[43]. Such benefits are still seen in the senior population, mainly in the context of ACS[10,44]. Hence, in line with most cardiac society recommendations, invasive revascularisation should still be offered to patients aged 80 years old and above with ACS, given its mortality benefit. Overall, clinicians need to appreciate the high cumulative incidence of various clinical outcomes in senior patients who have undergone PCI, taking into consideration the patient's quality of life and goals of care, and individualise the treatment regime where appropriate.

Limitations

Our meta-analysis consisted of multiple studies examining this topic, which spanned many countries in Europe, the Middle East, and Asia. This renders our findings applicable to an ethnically diverse population. However, we acknowledge a few limitations. Most of the articles included were observational studies, and there were few randomised controlled trials. However, randomised controlled trials are difficult to perform in this population, for reasons including difficulty in obtaining informed consent and difficulty in compliance to study protocol. Also, the investigators' concerns of potential negative trial results if senior patients are enrolled, due to their multiple comorbidities, may lead to a selection bias against senior patients.[45] Hence, they should be the continued focus of future studies. As many articles included data that crossed from the mid-2000s to the mid-2010s, we were unable to review temporal trends over the past 2 decades. As such, we were not able to exclude studies with the patients treated prior to the year 2010, and this may potentially confound our results. During this period, there was a shift towards the use of DES; hence, further studies are required to specifically examine differences between the pre-DES and DES eras. Furthermore, although frailty and sarcopenia are concepts that are gaining traction, most studies have yet to include frailty or sarcopenia in their assessment, thereby making it difficult to assess their effect on PCI outcomes. Lastly, there is variation in STEMI systems of care across various countries, and the ischaemic time was not well reported in many studies, which might have potentially affected the outcome.

Conclusions

There was a high mortality rate at 1 year and 3 years post-PCI in the overall population of senior patients aged 80 years old and above, regardless of indication. This necessitates further studies to explore the implications of these observations.

Impact on daily practice

With the increasing burden of coronary artery disease, especially in senior patients aged 80 years old and above, more studies are required to study the implications of the high mortality rate at 1 year and 3 years post-PCI, regardless of indication.

Funding

Ching-Hui Sia was supported by the National University of Singapore Yong Loo Lin School of Medicine's Junior Academic Faculty Scheme

Conflict of interest statement

The authors have no conflicts of interest to declare.

References

1. Khan MA, Hashim MJ, Mustafa H, Baniyas MY, Al Suwaidi SKBM, AlKatheeri R, Alblooshi FMK, Almatrooshi MEAH, Alzaabi MEH, Al Darmaki RS, Lootah SNAH. Global Epidemiology of Ischemic Heart Disease: Results from the Global Burden of Disease Study. *Cureus*. 2020;12:e9349.

2. World Health Organization. The top 10 causes of death. https://www.who.int/news-room/fact-sheets/detail/the-top-10-causes-of-death (Last accessed 5 June 2022).

3. Ibanez B, James S, Agewall S, Antunes MJ, Bucciarelli-Ducci C, Bueno H, Caforio ALP, Crea F, Goudevenos JA, Halvorsen S, Hindricks G, Kastrati A, Lenzen MJ, Prescott E, Roffi M, Valgimigli M, Varenhorst C, Vranckx P, Widimsky P; ESC Scientific Document Group. 2017 ESC Guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation: The Task Force for the management of acute myocardial infarction in patients presenting with ST-segment elevation of the European Society of Cardiology (ESC). *Eur Heart J*. 2018;39:119-77.

4. Collet JP, Thiele H, Barbato E, Barthélémy O, Bauersachs J, Bhatt DL, Dendale P, Dorobantu M, Edvardsen T, Folliguet T, Gale CP, Gilard M, Jobs A, Jüni P, Lambrinou E, Lewis BS, Mehilli J, Meliga E, Merkely B, Mueller C, Roffi M, Rutten FH, Sibbing D, Siontis GCM; ESC Scientific Document Group. 2020 ESC Guidelines for the management of acute coronary syndromes in patients presenting without persistent ST-segment elevation. *Eur Heart J*. 2021;42:1289-367.

5. O'Gara PT, Kushner FG, Ascheim DD, Casey DE Jr, Chung MK, de Lemos JA, Ettinger SM, Fang JC, Fesmire FM, Franklin BA, Granger CB, Krumholz HM, Linderbaum JA, Morrow DA, Newby LK, Ornato JP, Ou N, Radford MJ, Tamis-Holland JE, Tommaso CL, Tracy CM, Woo YJ, Zhao DX, Anderson JL, Jacobs AK, Halperin JL, Albert NM, Brindis RG, Creager MA, DeMets D, Guyton RA, Hochman JS, Kovacs RJ, Kushner FG, Ohman EM, Stevenson WG, Yancy CW; American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines. 2013 ACCF/AHA guideline for the management of

ST-elevation myocardial infarction: a report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines. *Circulation.* 2013;127:e362-425.

6. Amsterdam EA, Wenger NK, Brindis RG, Casey DE Jr, Ganiats TG, Holmes DR Jr, Jaffe AS, Jneid H, Kelly RF, Kontos MC, Levine GN, Liebson PR, Mukherjee D, Peterson ED, Sabatine MS, Smalling RW, Zieman SJ. 2014 AHA/ACC Guideline for the Management of Patients with Non-ST-Elevation Acute Coronary Syndromes: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. *J Am Coll Cardiol.* 2014;64:e139-228.

7. Lee PY, Alexander KP, Hammill BG, Pasquali SK, Peterson ED. Representation of elderly persons and women in published randomized trials of acute coronary syndromes. *JAMA.* 2001;286:708-13.

8. Alexander KP, Newby LK, Cannon CP, Armstrong PW, Gibler WB, Rich MW, Van de Werf F, White HD, Weaver WD, Naylor MD, Gore JM, Krumholz HM, Ohman EM; American Heart Association Council on Clinical Cardiology; Society of Geriatric Cardiology. Acute coronary care in the elderly, part I: Non-ST-segment-elevation acute coronary syndromes: a scientific statement for healthcare professionals from the American Heart Association Council on Clinical Cardiology: in collaboration with the Society of Geriatric Cardiology. *Circulation.* 2007;115:2549-69.

9. Alexander KP, Newby LK, Armstrong PW, Cannon CP, Gibler WB, Rich MW, Van de Werf F, White HD, Weaver WD, Naylor MD, Gore JM, Krumholz HM, Ohman EM; American Heart Association Council on Clinical Cardiology; Society of Geriatric Cardiology. Acute coronary care in the elderly, part II: ST-segment-elevation myocardial infarction: a scientific statement for healthcare professionals from the American Heart Association Council on Clinical Cardiology: in collaboration with the Society of Geriatric Cardiology. *Circulation.* 2007;115:2570-89.

10. Tegn N, Abdelnoor M, Aaberge L, Endresen K, Smith P, Aakhus S, Gjertsen E, Dahl-Hofseth O, Ranhoff AH, Gullestad L, Bendz B; After Eighty study investigators. Invasive versus conservative strategy in patients aged 80 years or older with non-ST-elevation myocardial infarction or unstable angina pectoris (After Eighty Study): an open-label randomised controlled trial. *Lancet.* 2016;387:1057-65.

11. Maron DJ, Hochman JS, Reynolds HR, Bangalore S, O'Brien SM, Boden WE, Chaitman BR, Senior R, López-Sendón J, Alexander KP, Lopes RD, Shaw LJ, Berger JS, Newman JD, Sidhu MS, Goodman SG, Ruzyllo W, Gosselin G, Maggioni AP, White HD, Bhargava B, Min JK, Mancini G, Berman DS, Picard MH, Kwong RY, Ali ZA, Mark DB, Spertus JA, Krishnan MN, Elghamaz A, Moorthy N, Hueb WA, Demkow M, Mavromatis K, Bockeria O, Peteiro J, Miller TD, Szwed H, Doerr R, Keltai M, Selvanayagam JB, Steg PG, Held C, Kohsaka S, Mavromichalis S, Kirby R, Jeffries NO, Harrell FE Jr, Rockhold FW, Broderick S, Ferguson TB Jr, Williams DO, Harrington RA, Stone GW, Rosenberg Y; ISCHEMIA Research Group. Initial Invasive or Conservative Strategy for Stable Coronary Disease. *N Engl J Med.* 2020;382:1395-407.

12. Plugge M. Successful ageing in the oldest old: objectively and subjectively measured evidence from a population-based survey in Germany. *Eur J Ageing.* 2021;18:537-47.

13. Smith J, Ryan LH. Chapter 16 - Psychological vitality in the oldest old. In: Schaie KW, Willis SL, editors. Handbook of the psychology of aging (Eighth edition). San Diego: Academic Press; 2016. p.303-19.

14. Baltes PB, Smith J. New frontiers in the future of aging: from successful aging of the young old to the dilemmas of the fourth age. *Gerontology.* 2003;49:123-35.

15. Petrová Kafková M. The " real " old age and the transition between the third and fourth age 1. *Sociológia.* 2016;48:622-40.

16. Stenvers E, Mars RC, Zuurmond RG. Frail Patients Benefit From Less Invasive Procedures. *Geriatr Orthop Surg Rehabil.* 2019;10:2151459319885283.

17. Mosquera C, Spaniolas K, Fitzgerald TL. Impact of frailty on surgical outcomes: The right patient for the right procedure. *Surgery.* 2016;160:272-80.

18. Nyaga VN, Arbyn M, Aerts M. Metaprop: a Stata command to perform meta-analysis of binomial data. *Arch Public Health.* 2014;72:39.

19. Lin L, Chu H. Meta-analysis of Proportions Using Generalized Linear Mixed Models. *Epidemiology.* 2020;31:713-7.

20. DerSimonian R, Laird N. Meta-analysis in clinical trials. *Control Clin Trials.* 1986;7:177-88.

21. Higgins JP, Thompson SG. Quantifying heterogeneity in a meta-analysis. *Stat Med.* 2002;21:1539-58.

22. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, Shamseer L, Tetzlaff JM, Akl EA, Brennan SE, Chou R, Glanville J, Grimshaw JM, Hróbjartsson A, Lalu MM, Li T, Loder EW, Mayo-Wilson E, McDonald S, McGuinness LA, Stewart LA, Thomas J, Tricco AC, Welch VA, Whiting P, Moher D. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *Syst Rev.* 2021;10:89.

23. Wells GA, Shea B, O'Connell Da, Peterson J, Welch V, Losos M, Tugwell P. The Newcastle-Ottawa Scale (NOS) for assessing the quality of nonrandomised studies in meta-analyses. https://www.ohri.ca/programs/clinical_epidemiology/oxford.asp (Last accessed 26 February 2021).

24. Helft G, Georges JL, Mouranche X, Loyeau A, Spaulding C, Caussin C, Benamer H, Garot P, Livarek B, Teiger E, Varenne O, Monségu J, Mapouata M, Petroni T, Hammoudi N, Lambert Y, Dupas F, Laborne F, Lapostolle F, Lefort H, Juliard JM, Letarnec JY, Lamhaut L, Lebail G, Boche T, Jouven X, Bataille S; e-MUST and CARDIO-ARSIF Registries. Outcomes of primary percutaneous coronary interventions in nonagenarians with acute myocardial infarction. *Int J Cardiol.* 2015;192:24-9.

25. Fach A, Bünger S, Zabrocki R, Schmucker J, Conradi P, Garstka D, Fiehn E, Hambrecht R, Wienbergen H. Comparison of Outcomes of Patients With ST-Segment Elevation Myocardial Infarction Treated by Primary Percutaneous Coronary Intervention Analyzed by Age Groups (<75, 75 to 85, and >85 Years); (Results from the Bremen STEMI Registry). *Am J Cardiol.* 2015;116:1802-9.

26. Papapostolou S, Dinh DT, Noaman S, Biswas S, Duffy SJ, Stub D, Shaw JA, Walton A, Sharma A, Brennan A, Clark D, Freeman M, Yip T, Ajani A, Reid CM, Oqueli E, Chan W; Melbourne Interventional Group Investigators. Effect of Age on Clinical Outcomes in Elderly Patients (>80 Years) Undergoing Percutaneous Coronary Intervention: Insights From a Multi-Centre Australian PCI Registry. *Heart Lung Circ.* 2021;30:1002-13.

27. Stergiopoulos K, Boden WE, Hartigan P, Möbius-Winkler S, Hambrecht R, Hueb W, Hardison RM, Abbott JD, Brown DL. Percutaneous coronary intervention outcomes in patients with stable obstructive coronary artery disease and myocardial ischemia: a collaborative meta-analysis of contemporary randomized clinical trials. *JAMA Intern Med.* 2014;174:232-40.

28. Avezum A, Makdisse M, Spencer F, Gore JM, Fox KA, Montalescot G, Eagle KA, White K, Mehta RH, Knobel E, Collet JP; GRACE Investigators. Impact of age on management and outcome of acute coronary syndrome: observations from the Global Registry of Acute Coronary Events (GRACE). *Am Heart J.* 2005;149:67-73.

29. Caretta G, Passamonti E, Pedroni PN, Fadin BM, Galeazzi GL, Pirelli S. Outcomes and predictors of mortality among octogenarians and older with ST-segment elevation myocardial infarction treated with primary coronary angioplasty. *Clin Cardiol.* 2014;37:523-9.

30. Goldberg RJ, Steg PG, Sadiq I, Granger CB, Jackson EA, Budaj A, Brieger D, Avezum A, Goodman S. Extent of, and factors associated with, delay to hospital presentation in patients with acute coronary disease (the GRACE registry). *Am J Cardiol.* 2002;89:791-6.

31. Fitzpatrick AL, Powe NR, Cooper LS, Ives DG, Robbins JA. Barriers to health care access among the elderly and who perceives them. *Am J Public Health.* 2004;94:1788-94.

32. van Gaans D, Dent E. Issues of accessibility to health services by older Australians: a review. *Public Health Rev.* 2018;39:20.

33. Brieger D, Eagle KA, Goodman SG, Steg PG, Budaj A, White K, Montalescot G; GRACE Investigators. Acute coronary syndromes without chest pain, an underdiagnosed and undertreated high-risk group: insights from the Global Registry of Acute Coronary Events. *Chest.* 2004;126:461-9.

34. Taylor CA, Bouldin ED, Greenlund KJ, McGuire LC. Comorbid Chronic Conditions Among Older Adults with Subjective Cognitive Decline, United States, 2015-2017. *Innov Aging.* 2020;4:igz045.

35. Principal causes of death. Ministry of Health Singapore. https://www.moh.gov.sg/resources-statistics/singapore-health-facts/principal-causes-of-death (Last accessed 26 February 2021).

36. Frencken JF, Donker DW, Spitoni C, Koster-Brouwer ME, Soliman IW, Ong DSY, Horn J, van der Poll T, van Klei WA, Bonten MJM, Cremer OL. Myocardial Injury in Patients With Sepsis and Its Association With Long-Term Outcome. *Circ Cardiovasc Qual Outcomes.* 2018;11:e004040.

37. Murali-Krishnan R, Iqbal J, Rowe R, Hatem E, Parviz Y, Richardson J, Sultan A, Gunn J. Impact of frailty on outcomes after percutaneous coronary intervention: a prospective cohort study. *Open Heart.* 2015;2:e000294.

38. Jernberg T, Hasvold P, Henriksson M, Hjelm H, Thuresson M, Janzon M. Cardiovascular risk in post-myocardial infarction patients: nationwide real world data demonstrate the importance of a long-term perspective. *Eur Heart J.* 2015;36:1163-70.

39. Su PH, Chen PY, Lee SY, How CK, Chien DK, Chang WH. Comparison of clinical presentations and outcomes between adult and elderly acute myocardial infarction patients in emergency department. Health Technology. 2019;3. https://ht.amegroups.com/article/view/5325/html (Last accessed 26 February 2021).

40. Šerpytis R, Puodžiukaitė L, Petrauskas S, Misonis N, Kurminas M, Laucevičius A, Šerpytis P. Outcomes of a percutaneous coronary intervention versus coronary artery bypass grafting in octogenarians. *Acta Med Litu.* 2018;25:132-9.

41. Sheridan BC, Stearns SC, Rossi JS, D'Arcy LP, Federspiel JJ, Carey TS. Three-year outcomes of multivessel revascularization in very elderly acute coronary syndrome patients. *Ann Thorac Surg.* 2010;89:1889-94.

42. Sliman H, Jaffe R, Rubinshtein R, Karkabi B, Zissman K, Flugelman MY, Zafrir B. Clinical features and outcomes of revascularization in very old patients with left main coronary artery disease. *Coron Artery Dis.* 2019;30:584-9.

43. Chacko L, P Howard J, Rajkumar C, Nowbar AN, Kane C, Mahdi D, Foley M, Shun-Shin M, Cole G, Sen S, Al-Lamee R, Francis DP, Ahmad Y. Effects of Percutaneous Coronary Intervention on Death and Myocardial Infarction Stratified by Stable and Unstable Coronary Artery Disease: A Meta-Analysis of Randomized Controlled Trials. *Circ Cardiovasc Qual Outcomes.* 2020;13:e006363.

44. Yudi MB, Jones N, Fernando D, Clark DJ, Ramchand J, Jones E, Dakis R, Johnson D, Chan R, Islam A, Farouque O, Horrigan M. Management of Patients Aged ≥85 Years With St-Elevation Myocardial Infarction. *Am J Cardiol.* 2016;118:44-8.

45. Shenoy P, Harugeri A. Elderly patients' participation in clinical trials. *Perspect Clin Res.* 2015;6:184-9.

Supplementary data

Supplementary Table 1. PRISMA checklist 2020.

Supplementary Table 2. Criteria of Newcastle-Ottawa scale.

Supplementary Table 3. Details of Newcastle-Ottawa scale.

Supplementary Table 4. Regions represented.

Supplementary Table 5. Summary of baseline characteristics.

The supplementary data are published online at: https://www.asiaintervention.org/ doi/10.4244/AIJ-D-21-00040

Supplementary data

Supplementary Table 1. PRISMA checklist 2020.

Section and topic	Item #	Checklist item	Location where item is reported
TITLE			
Title	1	Identify the report as a systematic review.	1
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	4
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	4
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	5
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	5
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	5
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	5
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	5
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	5
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	5
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	Suppl Material
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	5
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	5
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	5
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	5
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	5

Section and topic	Item #	Checklist item	Location where item is reported
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	5
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	5
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	Suppl material
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	5
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	6-7
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	6-7
Study characteristics	17	Cite each included study and present its characteristics.	6-7
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	Suppl material
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	6-7
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	6-7
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	6-7
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	6-7
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	6-7
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	Suppl material
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	Suppl material
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	7-9
	23b	Discuss any limitations of the evidence included in the review.	7-9
	23c	Discuss any limitations of the review processes used.	7-9
	23d	Discuss implications of the results for practice, policy, and future research.	7-9
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	NA

Section and topic	Item #	Checklist item	Location where item is reported
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	NA
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	NA
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	10
Competing interests	26	Declare any competing interests of review authors.	1
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	NA

From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n71

For more information, visit: http://www.prisma-statement.org/

Supplementary Table 2. Criteria of Newcastle Ottawa scale

Section	Subsection	Point given if:
Selection	Representativeness of the exposed cohort (1)	≥80 years old with PCI
	Selection of the non-exposed cohort (1)	Control group (no PCI, CABG only, or younger groups) was derived from the same pool of patient
	Ascertainment of exposure (1)	Hospital records Structured interviews
	Demonstration that outcome of interest was not present at start of study (1)	Excluded patients who are already at very high risk of mortality e.g., cardiac arrest
Comparability	Comparability of cohorts on the basis of the design or analysis (2)	Adjusted for Sex – 1 point Other comorbidities including CKD, heart failure, AF, valvular disease etc – 1 point
Outcome	Assessment of outcome (1)	Either: independent blind assessment OR record linkage
	Was follow-up long enough for outcomes to occur (1)	Specified at least **3 years**
	Adequacy of follow up of cohorts (1)	Specified at least **80%** followed up

Number in parentheses represents the number of points given for each subsection.

Supplementary Table 3. Details of Newcastle Ottawa scale

SN	Authors	Selection				Comparability	Outcome		
1	Abramik 2020	1	0	1	0	2	1	0	0
2	Aguiar 2017	1	1	1	0	2	1	0	0
3	Al-Khandra 2019	1	1	1	0	2	1	0	0
4	Alkhushail 2014	1	1	1	0	0	1	0	0
5	Ang 2020	1	0	0	0	0	0	0	0
6	Antonsen 2011	1	0	1	0	2	1	0	1
7	Appleby 2011	1	1	1	0	2	1	0	0
8	Ariza 2015	1	0	1	0	2	1	0	0
9	Baklanov 2006	1	0	1	0	2	1	0	0
10	Barywani 2015	1	1	1	0	2	1	1	0
11	Berezhnoi 2018	1	0	1	0	0	1	0	0
12	Boudou 2007	1	1	1	0	0	1	1	1
13	Bromage 2016	1	1	1	0	2	1	1	0
14	Cantarelli 2010	1	1	1	0	0	1	0	0
15	Caretta 2014	1	1	1	0	2	1	0	1
16	Chen B 2010	1	0	1	0	2	1	0	0
17	Chen L 2019	1	0	1	0	2	1	0	0
18	Chen R 2016	1	0	1	0	2	1	0	0
19	Cheng 2010	1	1	1	1	2	1	1	1
20	Christiansen 2013	1	1	1	0	0	1	0	0
21	Conrotto 2014	1	1	1	0	2	1	1	0
22	Couture 2018	1	1	1	0	2	1	0	0
23	Dahdouh 2012	1	1	1	0	2	1	0	0
24	D'anna 2015	1	0	1	0	0	1	0	1
25	de Belder 2014	1	0	1	1	2	1	0	0
26	de Franca 2018	1	0	1	1	2	1	0	1
27	El Khoury 2014	1	1	1	0	0	1	0	0
28	Elbadawi 2019	1	1	1	0	2	1	0	0
29	Fach 2015	1	1	1	0	2	1	0	0
30	Feldman 2006	1	1	1	0	1	1	0	0
31	Gaszewska-Zurek 2005	1	0	1	0	0	1	0	0
32	Gerber 2017	1	1	1	0	2	1	0	1
33	Gestal 2014	1	0	1	0	1	1	0	0
34	Gestal 2015	1	0	1	0	2	1	0	0
35	Gonçalves 2020	1	1	1	0	0	1	0	0
36	Gusai 2012	1	0	1	0	0	1	0	0
37	Helft 2015	1	1	1	0	2	1	0	0
38	Hirakawa 2006	1	1	1	0	2	1	0	0
39	Hong 2011	1	1	1	0	2	1	0	1
40	Hu 2012	1	0	1	0	2	1	0	0
41	Ilic 2015	1	1	1	0	1	1	0	1
42	Ipek 2016	1	1	1	0	1	1	0	0

43	Johnston 2015	1	0	1	0	0	1	0	1
44	Junker2010	1	0	1	0	0	1	0	0
45	Kashima 2010	1	1	1	0	1	1	0	1
46	Khera 2013	1	1	1	0	2	1	0	0
47	Kherad 2015	1	1	1	0	0	1	0	0
48	Kitabata 2017	1	1	1	0	1	1	0	1
49	Kojima 2018	1	1	1	1	1	1	0	0
50	Koutouzis 2009	1	1	1	0	0	1	0	0
51	Kurniawan 2016	1	1	1	1	0	1	0	0
52	Lahtela 2017	1	1	1	0	0	1	0	0
53	Lee H 2016	1	1	1	0	2	1	0	0
54	Lee J 2020	1	1	1	0	2	1	0	1
55	Lee K 2014	1	1	1	1	2	1	0	0
56	Leistner 2019	1	1	1	0	2	1	0	0
57	Li S 2018	1	0	1	0	1	1	0	0
58	Liang 2015	1	0	1	0	0	1	0	0
59	Lim 2020	1	0	1	1	1	1	0	0
60	Lockie 2010	1	1	1	0	0	1	0	0
61	Longo 2011	1	1	1	0	0	1	1	0
62	López-Palop, R. 2009	1	0	1	0	0	1	0	1
63	Lotan 2009	1	0	1	0	0	1	0	0
64	Louvard 2004	1	0	1	0	0	1	0	0
65	Maeno 2011	1	0	1	0	0	1	0	0
66	Mansencal 2010	1	1	1	0	0	1	0	1
67	Marcolino 2012	1	1	1	0	0	1	1	1
68	Marino 2019	1	0	1	0	2	1	0	0
69	Matsuo 2016	1	0	1	0	0	1	0	0
70	Mengi 2020	1	1	1	0	0	1	0	0
71	Merchant 2009	1	0	1	0	1	1	0	0
72	Mishra 2019	1	0	1	0	0	1	0	0
73	Miura 2014	1	1	1	0	2	1	0	1
74	Miura 2016	1	1	1	0	2	1	0	1
75	Mizuguchi 2016	1	1	1	1	0	1	0	1
76	Mohamed 2016	1	1	1	0	0	1	0	0
77	Monello 2016	1	1	1	0	0	1	0	0
78	Moonen 2010	1	1	1	0	1	1	0	0
79	Muraglia 2014	1	1	1	0	0	1	0	0
80	Muraglia 2017	1	1	1	0	0	1	0	0
81	Murphy 2012	1	1	1	1	1	1	0	0
82	Nicolaides 2016	1	0	1	0	0	1	0	0
83	Nishihara 2020	1	0	1	0	2	1	0	0
84	Oduncu 2013	1	1	1	1	2	1	1	1
85	Oqueli 2011	1	1	1	0	2	1	0	0
86	Papapostolou 2020	1	1	1	1	2	1	1	1

87	Parikh 2008	1	0	1	0	0	1	0	0
88	Park 2017	1	0	1	0	1	1	0	0
89	Piao 2014	1	0	1	0	0	1	0	0
90	Piao 2014	1	0	1	0	0	1	0	0
91	Ploumen 2020	1	0	1	0	0	1	0	0
92	Rana 2013	1	1	1	0	2	1	0	1
93	Rasania 2017	1	0	1	0	0	1	0	0
94	Reid 2019	1	0	1	0	0	1	0	0
95	Reinius 2018	1	1	1	1	2	1	0	0
96	Riedmaier 2016	1	1	1	0	0	1	0	0
97	Riedmaier 2018	1	0	1	0	0	1	0	0
98	Rynkowska-Kidawa 2015	1	1	1	0	0	1	0	0
99	Sahin 2017	1	1	1	0	0	1	0	0
100	Sappa 2017	1	1	1	0	0	1	0	0
101	Sawant 2017	1	1	1	0	0	1	0	0
102	Serpytis 2018	1	1	1	0	2	1	1	0
103	Shanmugam 2017	1	1	1	1	0	1	0	0
104	Sharma R 2017	1	1	1	1	2	1	0	0
105	Sharma V 2015	1	1	1	1	2	1	0	0
106	Sharma V 2020	1	1	1	0	2	1	0	0
107	Sheridan 2010	1	1	1	0	0	1	1	0
108	Shirasawa 2010	1	1	1	1	0	1	0	0
109	Showkathali 2014	1	1	1	0	2	1	0	0
110	Sillano 2013	1	1	1	0	0	1	0	0
111	Sliman 2019	1	1	1	0	2	1	1	0
112	Talapatra 2015	1	0	1	0	0	1	0	0
113	Tammam 2016	1	0	1	0	0	1	0	0
114	Teplitsky 2003	1	0	1	0	0	1	0	0
115	Tomioka 2019	1	1	1	0	1	1	1	1
116	Uthamalingam 2015	1	0	1	0	0	1	0	1
117	Valente 2008	1	1	1	0	1	1	0	1
118	Vandecasteele 2013	1	1	1	0	2	1	0	0
119	Vasaiwla 2012	1	0	1	0	0	1	0	0
120	Vijayakumar 2004	1	0	1	0	0	1	0	0
121	Völz 2019	1	1	1	0	2	1	0	0
122	Walsh 2006	1	0	1	0	0	1	0	0
123	Wang TY 2012	1	1	1	0	0	1	0	0
124	Wong 2019	1	0	1	0	0	1	0	0
125	Wongcharoenkiat 2012	1	1	1	0	0	1	0	0
126	Wu 2019	1	1	1	1	0	1	1	0
127	Xu 2019	1	0	1	0	0	1	0	1
128	Yamaji 2019	1	1	1	0	0	1	0	0
129	Yamanaka 2013	1	1	1	0	1	1	0	1
130	Yan 2015	1	0	1	0	0	1	0	0

131	Yudi 2016	1	0	1	0	0	1	0	0
132	Zeymer 2019	1	1	1	0	2	1	0	0

Supplementary Table 4. Regions represented.

Regions	No of studies
UK	15
USA	15
Japan	14
Italy	10
Australia	8
South Korea	7
China	6
Germany	6
Multinational	6
Netherlands	5
Canada	4
France	4
Spain	4
Sweden	4
Brazil	2
Denmark	2
Israel	2
Istanbul	2
Poland	2
Portugal	2
Belgium	1
Greece	1
Hong Kong	1
India	1
Lithuania	1
New Zealand	1
Russia	1
Singapore	1
Thailand	1
Turkey	1

Supplementary Table 5. Summary of baseline characteristics.

SN	Authors	Country	Time frame	Number of patients	Mean age	Mean follow up	%ACS	%MI	% Previous PCI	% Previous CABG	Special study group
1	Abramik 2020	Greece	Jan 2007-Dec 2016	782	83.67 (80-95)	1 year	NR	34.3%	NR	13.2%	
2	Aguiar 2017	Portugal	2010-2014	1025	84±3	1 year	94.7%	19.0%	12.7%	4.2%	
3	Al-Khandra 2019	USA	2002-2014	1544563	83.9± 3.2	In-hospital outcomes	62.3%	30.9%	NR	NR	
4	Alkhushail 2014	UK	Jan 2005- Feb 2010	186	83.9	1 year	100%	NR	NR	NR	STEMI
5	Ang 2020	Australia	NR	65	NR	In-hospital outcomes	69.2%	NR	NR	NR	
6	Antonsen 2011	Western Denmark	2002-2009	3792	83±2	1 year	64.7%	24.9%	14.4%	5.8%	
7	Appleby 2011	Canada	Apr 2000 - Sep 2007	404	87.5 ± 2.9	In-hospital outcomes	75.2%	38.4%	24.3%	17.3%	
8	Ariza 2015	Spain	2010-2011	498	83.8±3.2	2 years	100%	13.5%	7.4%	1.4%	STEMI
9	Baklanov 2006	USA	NR	197	NR	1 year	NR	NR	NR	NR	
10	Barywani 2015	Sweden	2006-2008	182	83.0	5 years	99.0%	NR	6.6%	NR	
11	Berezhnoi 2018	Russia	Jan 2014-Aug 2017	492	84.2	1 year	33.1%	26.0%	3.3%	1.8%	
12	Boudou 2007	France	Jan 2000-Dec 2001	197	82.56 ± 2.76	51.3 months (0.1-69 months)	93.9%	9.1%	23.9%	4.1%	
13	Bromage 2016	UK	Jan 2005 - Jul 2011	1051	84.2	3 years (1.2-4.6 years)	100%	17.3%	8.3%	4.4%	STEMI
14	Cantarelli 2010	Brazil	Jan 2002- Oct 2008	320	NR	In-hospital outcomes	NR	18.8%	NR	NR	
15	Caretta 2014	Italy	Jan 2008-Nov 2012	139	85.0	1 year	100%	21.6%	NR	NR	STEMI
16	Chen B 2010	China	Jan 2003-June 2007	140	85±3	14 ±11 months; 1 year reported	NR	14.3%	NR	NR	
17	Chen L 2019	China	Oct 2003- Oct 2012	133	84.1±3.9	In-hospital outcomes	100%	NR	NR	NR	
18	Chen R 2016	Singapore	2004-2015	142	NR	1 year	NR	NR	NR	NR	STEMI
19	Cheng 2010	Netherlands	Jan 2000-Dec 2005	319	83±2	Median 5.4 years (3- 9 years); 5 years outcome reported	45.1%	32.9%	25.1%	19.1%	DES vs BMS

20	Christiansen 2013	USA	Mar 2003-Nov 2006	199	NR	1 year	100%	NR	NR	NR	STEMI
21	Conrotto 2014	Multinational	Apr 2002-Apr 2006	218	83.6±3.2	1088 days (IQR 420-1458 days), MACE not included as MACCE (includes CVA) reported (n=85)	54.1%	NR	17.4%	11.0%	vs CABG, LM group
22	Couture 2018	Canada	2009, 2012	382	NR	In-hospital outcomes	NR	NR	NR	NR	
23	Dahdouh 2012	France	June 2004-Nov 2010	70	83.4± 2.6	30.5±24.2 months (4-80 months)	7.1%	21.4%	25.7%	11.4%	
24	D'anna 2015	Italy	Jan 2003-Jan 2004	44	NR	NR	NR	NR	NR	NR	NSTEMI
25	de Belder 2014	UK, Spain	2009-2011	800	83.5	1 year	NR	25.6%	11.5%	5.6%	DES vs BMS
26	de Franca 2018	Brazil	Jan 2010-Jan 2016	273	83.4	12-72 months;	NR	NR	NR	NR	CKD patients
27	El Khoury 2014	Canada	Jan 2013-Sep 2013	148	85± 3	295±115 days	NR	NR	20.9%	12.8%	
28	Elbadawi 2019	USA	2002-2013	377653	NR	In-hospital outcomes	NR	NR	NR	NR	
29	Fach 2015	Germany	Jan 2006 - Jul 2013	179	NR	1 year	100%	NR	NR	NR	STEMI
30	Feldman 2006	USA	Jan 2000-Dec 2001	6453	83.1	In-hospital outcomes	10.4%	NR	NR	21.7%	
31	Gaszewska-Zurek 2005	Poland	Jul 2002-Jul2003	39	NR	1 year	NR	NR	NR	NR	
32	Gerber 2017	UK	Apr 2006-Nov 2011	253	83.7±3	30.8±2.7 months	21.3%	28.5%	15.0%	7.1%	
33	Gestal 2014	Spain	NR	399	NR	2.4±2.1 years	100%	NR	NR	NR	
34	Gestal 2015	Spain	Jan 2008 - Apr 2014	169	NR	588 days (235-1281)	NR	NR	NR	NR	Transradial vs transfemoral
35	Gonçalves 2020	Portugal	Oct 2010-Oct 2018	237	87± 2	1 year	100%	27.8%	16.5%	6.3%	NSTEMI group
36	Gusai 2012	Italy	Jan 2009-Dec 2011	48	86.9	NR	47.9%	NR	NR	NR	

37	Helft 2015	France	Jan 2003- Dec 2011	418	92.9 ± 2.7	In-hospital outcomes	100%	NR	NR	NR	STEMI
38	Hirakawa 2006	Japan	Jan 2001-Dec 2003	211	83.32 ± 0.2	In-hospital outcomes	NR	10.4%	NR	NR	
39	Hong 2011	USA	2006-2008	675	82.5±2.4	1 year	50.2%	35.3%	37.2%	12.3%	SES group
40	Hu 2012	China	May 2003-May 2007	268	82.7	In-hospital outcomes	43.3%	56.7%	10.4%	4.9%	
41	Ilic 2015	Multinational	NR	781	82.75±2.59	1 year	44.2%	23.7%	37.0%	10.0%	DES group
42	Ipek 2016	Istanbul	Jan 2012-Jun 2014	126	83.1±3.2	In-hospital outcomes	100%	17.5%	NR	9.5%	STEMI
43	Johnston 2015	UK	2014	257	NR	3 month	NR	NR	NR	NR	
44	Junker2010	Denmark	2002-2009	1135	87.5±2.7	1 year	47.0%	NR	NR	NR	
45	Kashima 2010	Japan	Jan 2002- Apr 2008	32	83±4	2.7 years ±1.6 years	62.5%	0.0%	NR	NR	
46	Khera 2013	USA	2001-2010	90567	84.3± 36	In-hospital outcomes	100%	85.7%	NR	NR	STEMI
47	Kherad 2015	Germany	2007-2012	375	NR	31 months	38.1%	NR	NR	NR	
48	Kitabata 2017	Japan	Jan 2013-May 2015	54	84.1±3.9	1 year	31.5%	22.2%	44.4%	1.9%	EES group
49	Kojima 2018	Japan	Jan 2011- Dec 2013	3865	NR	In-hospital outcomes	NR	NR	NR	NR	
50	Koutouzis 2009	Sweden	Jan 2004-Dec 2008	22	92.0	30 day outcomes	100%	9.1%	0.0%	0.0%	STEMI
51	Kurniawan 2016	China	2012-2014	308	82.7	1 year outcomes	NR	25.0%	29.2%	NR	
52	Lahtela 2017	Multinational	NR	195	82.9±2.6	1 year	16.4%	29.2%	12.8%	10.8%	AF
53	Lee H 2016	South Korea	Jan 2005-Dec 2010	1945	83.0	1 year	96.5%	4.9%	4.8%	NR	Transradial vs transfemoral
54	Lee J 2020	South Korea	2006-2015	24	90.8±1.6	30 months	NR	16.7%	NR	NR	
55	Lee K 2014	South Korea	Nov 2005-Dec 2007	1682	NR	1 year	99.3%	3.9%	4.5%	0.5%	
56	Leistner 2019	Germany	Jan 2009- Dec 2017	1238	83.4	233 days	58.0%	16.2%	24.2%	11.1%	BMI
57	Li S 2018	USA	2000-2015	786	NR	In-hospital outcomes	16.0%	NR	27.9%	NR	

58	Liang 2015	New Zealand	May 2006-Jun 2010	151	83±3	5 years	60.9%	NR	NR	NR	
59	Lim 2020	Australia	Jan 2013- Dec 2017	1875	84.2±3.4	30 days	100%	NR	33.4%	15.2%	NSTEACS
60	Lockie 2010	UK	2005-2009	514	83±2.68	In-hospital outcomes	NR	42.8%	18.7%	13.6%	
61	longo 2011	Italy	Jul 2002-Dec 2004	145	NR	53 months	NR	NR	NR	NR	
62	López-Palop, R. 2009	Spain	Mar 2002-Nov 2006	176	82.8	26.3 months	NR	20.5%	5.1%	6.8%	DES vs BMS
63	Lotan 2009	Multinational		56	NR	1 year	NR	NR	NR	NR	
64	Louvard 2004	Multinational	Dec 2001-Jul 2003	377	82.8	In-hospital outcomes	10.3%	18.6%	19.4%	9.3%	Transradial vs transfemoral
65	Maeno 2011	Japan	NR	35	NR	902 ± 643 days	NR	NR	NR	NR	
66	Mansencal 2010	France	Jan 1996- Dec 2005	152	83.9± 3.3	30±28 months	100%	28.9%	NR	NR	
67	Marcolino 2012	Netherlands	Jan 2000-Dec2005	291	82.0	30 days outcomes	15.1%	12.4%	4.5%	3.1%	
68	Marino 2019	Italy	May 2009-Jan 2018	242	87.7	388 days	33.1%	NR	NR	NR	
69	Matsuo 2016	Japan	Sep 2004-Aug 2013	264	84±3	2 years	NR	NR	NR	NR	DES vs BMS
70	Mengi 2020	UK	2006-2012	127	NR	2 years	100%	NR	NR	NR	STEMI
71	Merchant 2009	USA	Jan 2002-Dec 2005	179	84.0	In-hospital outcomes	50.8%	18.4%	17.3%	11.7%	STEMI vs elective
72	Mishra 2019	USA	2010-2014	297378	NR		NR	NR	NR	NR	DES vs BMS
73	Miura 2014	Japan	Aug 2012-Jul 2013	441	84±3.4	In-hospital outcomes	NR	NR	NR	NR	
74	Miura 2016	Japan	Aug 2012-Jul 2013	441	84±3.4	1 year	NR	23.1%	NR	6.8%	
75	Mizuguchi 2016	Japan	Jan 2008 - Dec 2012	52	85.5	30 days outcomes	100%	11.5%	9.6%	NR	STEMI
76	Mohamed 2016	UK	Jan 2012-Jan 2015	312	NR	1 year	83.0%	NR	NR	NR	

77	Monello 2016	Italy	Jan 2012-Jul 2015	82	NR	522±325 days	NR	NR	NR	NR	
78	Moonen 2010	Netherlands	2006	98	83.5±3.4	1 year	NR	24.5%	10.2%	4.1%	
79	Muraglia 2014	Italy	Jan 2007 - Jun 2013	206	87.2	In-hospital outcomes	100%	NR	NR	NR	Radial approach
80	Muraglia 2017	Italy	Jan 2012-Dec 2016	107	88.0	1 year	100%	NR	NR	NR	CKD
81	Murphy 2012	Australia	Sep 2005 - Jul 2011	224	85.0	In-hospital outcomes	100%	24.1%	12.1%	12.1%	STEMI
82	Nicolaides 2016	Australia	Sep 2012-Dec 2015	140	82.9±2.7	In-hospital outcomes	99.3%	9.3%	NR	NR	
83	Nishihara 2020	Japan	2009-2017	546	84.5	In-hospital outcomes	64.8%	12.6%	NR	NR	
84	Oduncu 2013	Istanbul	Jan 2006-Apr 2009	179	82.0	42 months	100%	8.9%	14.5%	9.5%	STEMI
85	Oqueli 2011	Australia	Nov 2004-Jan 20007	102	87.3±2.4	In-hospital outcomes	14.7%	29.4%	20.6%	34.3%	
86	Papapostolou 2020	Australia	Jan 2005-Jun 2017	3282	84±3	30 day outcomes	71.0%	33.7%	26.3%	13.0%	
87	Parikh 2008	USA	Jan 2001-Aug 2006	32	91.5±1.5	1 year	100%	NR	NR	12.5%	
88	Park 2017	South Korea	NR	68	NR	3 years	NR	NR	4.4%	NR	
89	Piao 2014	South Korea	Nov 2005-Apr 2012	760	83.7	1 year	100%	4.7%	7.6%	0.4%	NSTEMI, delayed vs early intervention
90	Piao 2014	South Korea	Feb 2009-Mar 2012	509	84.8	1 year	100%	4.1%	2.4%	NR	STEMI, DES vs BMS
91	Ploumen 2020	Netherlands	NR (pooled analysis)	671	82.7±2.55	1 year	68.4%	26.7%	23.8%	13.1%	DES
92	Rana 2013	UK	2006-2010	294	88±2	1 year	61.2%	33.3%	10.9%	5.8%	
93	Rasania 2017	USA	Jan 2009-Dec 2014	2301	NR	1year	NR	NR	NR	NR	
94	Reid 2019	UK	2013-2018	164	NR	1 year	NR	NR	NR	NR	
95	Reinius 2018	Sweden	2011-2014	4158	86±4	2.2 years	100%	40.6%	26.4%	NR	NSTEMI

96	Riedmaier 2016	Germany	2009-2013	190	91.7	In-hospital outcomes	NR	NR	NR	NR	STEMI
97	Riedmaier 2018	Germany	2009-2014	4551	83.8	In-hospital outcomes	NR	NR	NR	NR	NSTEMI
98	Rynkowska-Kidawa 2015	Poland	Jan 2012-Jan 2013	82	88.6±2.1 years	In-hospital outcomes	65.9%	40.2%	34.1%	17.1%	
99	Sahin 2017	Turkey	Jan 2005-Dec 2014	42	91.2±2.4	26.5± 20.1 months	100%	11.9%	14.3%	0.0%	STEMI
100	Sappa 2017	Italy	Jan 2007- Dec 2013	126	88±2	898 days	100%	12.7%	4.0%	4.8%	STEMI
101	Sawant 2017	USA	Jan 2005-Dec 2014	274	91.8 ± 1.6	1 year	53.6%	41.6%	25.9%	23.7%	
102	Serpytis 2018	Lithuania	Jan 2012-Dec 2014	369	83.0	3 year	81.0%	34.1%	23.0%	11.4%	CABG vs PTCA
103	Shanmugam 2017	Australia	Jan 2010 - Dec 2012	293	83.8± 3.4	In-hospital outcomes	64.2%	NR	31.1%	11.6%	
104	Sharma R 2017	Canada	Apr 2009 - Jun 2015	184	84.6	1 year	100%	19.0%	NR	NR	STEMI
105	Sharma V 2015	UK	2005-2010	57	83.0	1 year	100%	15.8%	NR	NR	STEMI
106	Sharma V 2020	UK	2014-2017	71	83.6 ± 2.6	In-hospital outcomes	NR	50.7%	36.6%	11.3%	Rotablation
107	Sheridan 2010	USA	Jan 2003-Mid Oct 2004	4338	87.7	3 years	24.3%	NR	NR	NR	CABG vs PTCA
108	Shirasawa 2010	Japan	2003-2007	42	88.5±3.5	6 months	NR	23.8%	16.7%	2.4%	
109	Showkathali 2014	UK	Sep 2009-Nov 2011	236	85±4	30 day	100%	23.3%	NR	3.0%	STEMI
110	Sillano 2013	Multinational	Apr 2002-Jun 2009	146	91.6	23.7 months ± 20 months	23.3%	28.8%	12.3%	5.5%	
111	Sliman 2019	Israel	2003-Mid 2018	74	86±3.5	3 years	20.3%	NR	50.0%	NR	Left main disease
112	Talapatra 2015	India	NR	65	NR	6 months	NR	NR	NR	NR	
113	Tammam 2016	Japan	Jan 2010-Dec 2014	2530	83±3	30 days outcomes	2.5%	2.8%	4.2%	NR	Transradial vs transfemoral
114	Teplitsky 2003	Israel	Nov 2000-Jan 2002	97	84±3	6 months	28.9%	42.3%	NR	NR	
115	Tomioka 2019	Japan	2012-2014	95	89.0	1134 ± 300 days	NR	2.1%	NR	NR	

116	Uthamalingam 2015	UK	Jan 2000 - Mar 2008 (BMS); Apr 2003-Mar 2008 (DES)	320	83.6	1 year	18.8%	12.2%	4.1%	8.1%	DES vs BMS
117	Valente 2008	Italy	Jan 2000- Dec 2005	88	88.2±5.6	21.5 outcomes	100%	14.8%	8.0%	2.3%	STEMI
118	Vandecasteele 2013	Belgium	Jan 2007 - Dec 2010	840	83.0	In-hospital outcomes	100%	NR	NR	NR	STEMI
119	Vasaiwla 2012	USA	Apr 2003-Sep 2008	2435	NR	1 year	NR	NR	NR	NR	
120	Vijayakumar 2004	Netherlands	Apr 2002 -Mar 2003	46	82±2.4	378 days ± 69 days	60.9%	30.4%	19.6%	19.6%	SES group
121	Völz 2019	Sweden	Jan 2000 - Dec 2011	586	83.1±2.9	1 year	NR	26.3%	8.0%	7.8%	NSTEMI
122	Walsh 2006	UK	Jan 2003 - Dec 2004	53	81.0	1 year	NR	NR	18.9%	15.1%	
123	Wang TY 2012	USA	Jan 2004-Dec 2008	42154	87.0	640.8 days ± 423.5	NR	26.4%	25.3%	18.8%	DES vs BMS
124	Wong 2019	New Zealand	2014-2016	204	87.6 ±2.7	In-hospital outcomes	NR	NR	16.2%	4.9%	
125	Wongcharoenkiat 2012	Thailand	Jan 2005-Dec 2007	202	NR	2 years	NR	NR	NR	NR	
126	Wu 2019	China	Jan 2010-Jan 2016	292	81.5±1.9	25 months	98.6%	34.6%	28.4%	NR	CABG vs PTCA
127	Xu 2019	China	Jan 2006-Apr 2011	254	85.7	362 days	74.4%	26.8%	23.2%	7.1%	Transradial vs transfemoral
128	Yamaji 2019	Japan	2014-2016	138459	84.7	In-hospital outcomes	41.8%	7.5%	13.0%	1.4%	
129	Yamanaka 2013	South Korea	Jan 2006-Dec 2008	1494	84±4	1 year	100%	3.9%	4.4%	NR	DES
130	Yan 2015	Hong Kong	Sep 2009-Jun 2011	100	NR	2 years	NR	NR	NR	NR	
131	Yudi 2016	Australia	2005-2014	170	NR	1 year	NR	NR	NR	NR	STEMI
132	Zeymer 2019	Germany	2010-2015	159	88± 2.5	In-hospital outcomes	100%	35.2%	17.6%	6.3%	